Manufacturing Science and Technology Group
Room 18 - Session MS-ThA

Working with Government Labs and User Facilities

Moderators: Bridget Rogers, Vanderbilt University, Mikel Holcomb, West Virginia University

2:20pm **MS-ThA-1 Tackling Fundamental and Applied Problems Using EMSL Capabilities - Examples of Applying Surface and Interface Sensitive Tools to Biological Systems**, *C Anderton, D Baer, M Engelhard,* ***Scott Lea***, Pacific Northwest National Laboratory

Tackling many of the most difficult and pressing scientific challenges of today requires an array of advanced instrumentation and expertise. The Environmental Molecular Sciences Laboratory (EMSL) is a US Department of Energy national scientific user facility with a wide range of advanced research capabilities that provides access to users with specialized research needs. EMSL's mission is to lead molecular-level discoveries for the Department of Energy and its Office of Biological and Environmental Research that translate to predictive understanding and accelerated solutions for national biological, energy, and environmental challenges. To achieve this goal, EMSL science is focused into four Science themes: atmospheric aerosol systems, biological dynamics and design, terrestrial and subsurface ecosystems, and molecular transformations (www.emsl.pnnl.gov). Dynamic processes that occur at interfaces underpin research in these science focus areas. EMSL provides an array of unique and advanced capabilities to facilitate interfacial research, including state of the art spectroscopy, microscopy, magnetic resonance, and computational capabilities. EMSL has also made significant strides in the development of *in situ* capabilities designed to interrogate these interfaces in real-time and in a variety of environments. By providing integrated experimental and computational resources for discovery and technological innovation in molecular sciences, EMSL particularly encourages endeavors that utilize multiple capabilities. This talk will focus attention on the application of several surface sensitive and interface tools to biological systems. Like other DOE national user facilities, access to EMSL capabilities is through a proposal and peer review process and can be no-cost for work to be disseminated to the scientific community through open literature publication. Numerous national scientific user facilities are making efforts to increase industrial utilization, and EMSL has recently taken steps to facilitate access to its capabilities for industrial users.

2:40pm **MS-ThA-2 Opportunities for Users at the Center for Nanoscale Materials**, ***Kathleen Carrado Gregar,*** Argonne National Laboratory

The Center for Nanoscale Materials (CNM) at Argonne National Laboratory is a premier user facility providing expertise, instrumentation, and infrastructure for interdisciplinary nanoscience and nanotechnology research. Academic, industrial, and international researchers can access the center through its user program for both nonproprietary (at no cost) and proprietary research. As a Department of Energy (DOE) funded research center, the CNM is at the forefront of discovery science that addresses national grand challenges encompassing the topics of energy, information, materials and the environment. The scientific strategy of the CNM is consolidated under the following three crosscutting and interdependent scientific themes. Collectively, they aim at the discovery and hierarchical integration of materials across different length scales, at the extremes of temporal, spatial, and energy resolutions: (a) Quantum materials and phenomena (b) Manipulating nanoscale interactions, and (c) Synthesis of nano-architectures for energy, information and functionality. Embedded within these three themes and supporting them are the vector capabilities of X-ray microscopy, electron microscopy, and computational materials science.

Unique capabilities at CNM include a premier clean room with advanced lithography and deposition capabilities, expansive synthesis and nanofabrication resources, a hard x-ray nanoprobe at the Advanced Photon Source synchrotron, myriad scanning probes including low temperature, ultrahigh vacuum STMs, TEMs with in situ holders and chromatic aberration-correction, a 30 TFlop supercomputer, and ultrafast optical probes. A key CNM asset includes outstanding staff with expertise in synthesis, nanophotonics, scanning probe and electron microscopy, nanofabrication, and theory, simulation and modeling. Core technological materials range from 2D layered materials to nanocrystalline diamond. All capabilities and expertise are available through peer-reviewed user proposals; access is free of charge for non-proprietary research. CNM is one of DOE's premier Nanoscale Science Research Centers serving as the basis for a national program encompassing new science, new tools, and new computing capabilities for research at the nanoscale (https://nsrcportal.sandia.gov). Recent staff and user research highlights will be presented, painting a picture of present and future nanoscience and nanotechnology at the CNM (www.anl.gov/cnm).

The Center for Nanoscale Materials, an Office of Science user facility, is supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under contract no. DE-AC-02-06CH11357.

3:00pm **MS-ThA-3 The CNST NanoFab at NIST:** ***Nanofabrication for US Commerce***, *V Luciani,* ***Chen Zhang***, National Institute of Standards and Technology, Center for Nanoscale Science and Technology

The NIST Center for Nanoscale Science and Technology (CNST) supports the U.S. nanotechnology enterprise from discovery to production. As part of the CNST, the shared-use NanoFab provides its users rapid access to a comprehensive suite of tools and processes for nanoscale fabrication and measurement. The CNST NanoFab at NIST is part of the Department of Commerce and therefore puts a high priority on operating a business friendly, easily accessible facility. The same rates are applied to all users, whether from industry, academia or NIST. Applications are accepted at any time and are reviewed and processed every week. Also, NIST does not claim any inherent rights to inventions made in the course of a NanoFab project. Your intellectual property rights are not affected. The NanoFab features a large, dedicated facility, with tools operated within an ISO 5 (class 100), 750 m^2 (8,000 ft^2) cleanroom and in adjacent laboratories that have superior air quality along with temperature, humidity, and vibration control. Over 80 major process tools are available, including but not limited to e-beam lithography, 5x reduction stepper photolithography, nano-imprint lithography, laser writing for mask generation, scanning and transmission electron microscopy, three Focused Ion Beam (FIB) systems, metal deposition, plasma etching, chemical vapor deposition, atomic layer deposition, deep silicon etching, ion beam etching and a soft-lithography lab. The NanoFab staff consists of scientists, engineers and technicians that specialize in all areas of nanofabrication and provide training and ongoing technical assistance to users. Our goal is to be a catalyst to our users' success and to help nurture nanotechnology commerce in the Unites States. Project applications and instructions are easily available on the web at www.nist.gov/cnst/nanofab. Users inside NIST and from all around the country are provided on-line access to tool schedules and the tool reservation system. From physicists, engineers and biologists to medical researchers, users find common ground at the nanoscale in the CNST NanoFab.

3:20pm **MS-ThA-4 Research Opportunities at the Cornell NanoScale Science and Technology Facility**, ***Michael Skvarla***, Cornell NanoScale Science and Technology Facility

The Cornell NanoScale Science and Technology Facility (CNF) is a member of NNCI, a network of open-access facilities partially subsidized by the US National Science Foundation to provide researchers with rapid, affordable, shared access to advanced nanofabrication tools and associated staff expertise. Hundreds of researchers worldwide (from academia, industry, and government) utilize CNF to make structures and systems from the nanometer scale to the centimeter scale. CNF offers extensive capabilities in electron-beam lithography, stepper photolithography, soft lithography, and direct-write tools for rapid prototype development, along with the flexibility to accommodate diverse projects and to deposit, grow, and etch a wide variety of materials. CNF's technical staff is dedicated full-time to user support, providing one-on-one help with process development, tool training, and troubleshooting. They can offer expertise in a wide range of fabrication topics, including electronics, photonics, magnetics, MEMS, materials, basic studies in chemistry and nanostructure physics, fluidics, and the life sciences and bioengineering (more than 30% of CNF's users now focus on biology). All researchers are welcome and all reasonable interactions are possible; no experience in nanofabrication is necessary. A central part of CNF's mission is education and outreach, with a special interest in assisting users from "non-traditional" fields seeking assistance to implement nanofabrication techniques for the first time. CNF's user program is designed to provide the most rapid possible access (typically 2 weeks) with the lowest possible barriers to entry (users retain full control of their IP, with no entanglement by CNF or Cornell University). Projects range from extensive, long-term device development to short-term use of specific tools, advanced capabilities, or singular staff expertise.

This talk will explore the CNF tool set, areas of expertise, types of services and advice available, and examples of ongoing work with the hope of stimulating ideas and possibilities.

We invite you to explore the CNF and NNCI and discuss ways we can help bring your research visions to fruition. As a first step, CNF's User Program Managers will at no cost provide detailed processing advice and cost estimates for potential new projects. The CNF technical staff meets every Wednesday afternoon for conference calls where we welcome questions about any topic related to nanofabrication. Visit cnf.cornell.edu to contact us and get started.

4:00pm **MS-ThA-6 Shyne - Allowing Users to Leverage $800 Million in Nanotechnology Research, Education, Infrastructure & Facilities at Northwestern and the University of Chicago**, ***Peter Duda,*** University of Chicago*; B Meyers,* Northwestern University

Welcome to the Soft and Hybrid Nanotechnology Experimental (SHyNE) Resource, an NSF-NNCI program! SHyNE is a new national resource that provides academic, small business and industry researchers access to cutting-edge nanotechnology facilities and expertise. In addition to traditional nanotechnology tools, SHyNE ensures the integration of soft (biological) nanostructures with the backbone of enabling hard materials, for applications such as microfluidic modules for bio-sensors and synthetic scaffolds for tissue regeneration, among others.

SHyNE streamlines our nanotechnology facilities, providing unique and integrated capabilities for internal Northwestern and UChicago researchers as well as external users, especially small and medium enterprises and startup companies. SHyNE further cements our leadership in nanotechnology and related advanced materials research, education and outreach.SHyNE deepens existing collaborations between Northwestern and UChicago and is expected to draw a variety of researchers from the Chicago area, the greater Midwest and nationally. SHyNE also offers regional colleges and public institutions, including museums, the opportunity to access research and training instrumentation under one umbrella. Through this program and the combined capabilities of the SHyNE facilities, we will connect state-of-the-art research facilities to academic, government and commercial programs across the Midwest, which in turn will lead to life-enhancing breakthroughs. As one of the 16 members of the nanotechnology network, SHyNE will benefit from and contribute to the vast resources of national collaboration of world-class peer institutions.

We wholeheartedly welcome you to use our facilities under the guidance and instruction of our talented staff, discover our unique instrumentation and capabilities, and find out more what SHyNE can do for you!

4:20pm **MS-ThA-7 Science Opportunities with Soft X-Rays for Users at the Advanced Light Sources**, ***Zahid Hussain,*** Advanced Light Source, Lawrence Berkeley National Laboratory

Sharper and sharper experimental tools are often crucial for understanding of novel physical phenomena and making new discoveries. Today in condensed matter physics we are experiencing need for revolutionary new instrumentation for understanding interplay of many degrees of freedom interacting at different energy, length and time scales. These interactions lead to new phases of matter and emergent phenomena such as high temperature superconductors, topological insulators and thermoelectric materials, to name a few. The primary focus of my talk is to present the science opportunity, through various examples, upon the necessity for advanced techniques and instrumentation to elucidate the application of soft x-ray synchrotron radiation for unraveling the emergent phenomena in quantum materials and energy related challenges.

4:40pm **MS-ThA-8 Research Opportunities and How to Become a User at the Center for Functional Nanomaterials**, ***Samuel Tenney,*** Brookhaven National Laboratory

The Center for Functional Nanomaterials (CFN) is a Department of Energy (DOE) Nanoscale Science Research Center located at Brookhaven National Laboratory. The CFN is a state of the art user facility for both proprietary and nonpropietary research with currently more than 500 users per year from industry, academia, and other government labs that publish well over 300 papers per year. The CFN is comprised of 5 research groups (interface science and catalysis, soft and bio materials, electronic nanomaterials, electron microscopy, and theory and computation) that are centered around the 3 strategic themes of the CFN including the study of Nanomaterials in Operando Conditions, Nano-architectures for Energy Solutions, and Self-assembled Nanomaterials by Design. The CFN has a very strong synergy with the National Synchrotron Light Source II (NSLS-II) and currently partners in the operation of 3 endstations that are used for the characterization of nanomaterials. The CFN houses a state-of-the-art cleanroom with world record 1 nanometer lithography capabilities among others. The CFN has over 50 staff members with expertise in a wide variety of areas related to nanoscale science that are dedicated to user support and the development and fostering of an extensive user community. Since its inception the CFN was designed with the idea of housing a complete suite of equipment, techniques, and technical staff to tackle the biggest challenges at the forefront of nanoscale science and technology all under one roof. We will also present how to become a user and discuss the process of applying for time to use the CFN's resources.

5:00pm **MS-ThA-9 Opportunities at the Center for Nanophase Materials Sciences**, ***Arthur Baddorf,*** Oak Ridge National Laboratory

The Center for Nanophase Materials Sciences (CNMS) at Oak Ridge National Laboratory (ORNL) is a DOE Office of Science User Facility that provides a national and international user community access to expertise and equipment for a broad range of nanoscience research, including nanomaterials synthesis, nanofabrication, imaging/microscopy/characterization, and theory/modeling/simulation. CNMS also acts as gateway for the nanoscience community to benefit from ORNL's neutron sources (SNS and HFIR) and computational resources. CNMS facilities are accessible based on peer-reviewed proposals and are offered at no cost to users who intend to publish their results.

In addition to a broad assortment of nanomaterials characterization tools, the CNMS has particular expertise in the following capabilities:

• Nanofabrication - The CNMS Nanofabrication Research Laboratory houses 10,000 ft2 of class 100/1000 clean room space for material modification using advanced lithographic, etching, thin-film deposition, and characterization tools.

• Bio-Inspired Nanomaterials - The CNMS offers capabilities to manipulate and image hydrated biological samples, and to create inorganic nanostructures of biological interest.

• Inorganic and Hybrid Nanomaterials Synthesis - Synthesis of nanostructures and thin films are performed by CVD and PLD with real-time diagnostics, including 2D layered materials, carbon nanostructures, oxide films, as well as hybrid organic/inorganic perovskite films, with wet/dry assembly of these materials into optoelectronic device architectures.

• Macromolecular Nanomaterials Synthesis - Laboratories include a wide range of polymer synthesis capabilities with special emphasis on selective deuteration and ionic polymerization

• Chemical Imaging – In addition to elemental distribution, bonding and chemical configuration is obtained using energy and mass spectroscopies.

• Electron and Atom Probe Microscopy - Sub-Ångstrom electron microscopy and spectroscopy, soft-matter TEM, and atom probe and electron tomographies are available.

• Scanning Probe Microscopy - Scanning tunneling and atomic force microscopies and spectroscopies in a range of environments for mapping of physical and electronic structure, electronic and ionic transport, spin, thermovoltage, electromechanics, magnetism, and dissipation.

• Nanomaterials Theory Institute - The NTI provides and advances capabilities for theory and high-performance simulation to enable fundamental understanding of physical and chemical properties of nanoscale materials.

5:20pm **MS-ThA-10 Research Opportunities at the National High Magnetic Field Laboratory**, ***Eric Palm,*** National High Magnetic Field Laboratory

The National High Magnetic Field Laboratory (MagLab) is the largest and highest powered magnet lab in the world. With more than 1700 users annually making use of its facilities it is a unique laboratory for basic research on topics as varied as materials, energy and life. This presentation will focus on those research capabilities as well as the technical challenges involved in creating the worlds highest magnetic fields for research.

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